Space Weather Technical Forecast

Issued on Saturday, 10 August 2024 at 01:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-class flares expected with a chance of isolated X-class flares. Occasional G1-G2/Minor to Moderate geomagnetic storms likely, mainly today and tomorrow (10 and 11 Aug).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with low level M-class flares observed in the past 24 hours. The largest flare was M4.5 at 09/2123 UTC from AR3777. There are currently nine numbered sunspot regions on the disc, of which five groups are magnetically complex or very complex. Of these AR3780 (Fho/beta-gamma-delta) remains the largest region on the disc and has produced flare activity, but AR3784 (Dkc/beta-delta) is statistically the most likely to produce a significant flare. However, AR3777 (fai/beta-gamma) has been the most active over recent days, and AR3774 and AR3781 (Dso/beta-delta) have also contributed to flare activity, despite AR3774's simpler magnetic structure (Eai/beta). AR3782 is also a region to note, due to its recent growth in spot number and magnetic complexity (now classified as Eai/beta-gamma). The largest flare of the period is expected to have produced a CME, which is likely to have an Earth directed component. Once imagery is available an analysis will be undertaken.

Solar Wind / Geomagnetic Activity: Slow-ambient solar wind conditions mostly persisted through the period, although wind speeds did occasionally briefly touch into slightly elevated levels, peaking at 439 km/s at 09/1753UTC. Density remained at or below average. Interplanetary Magnetic Field, Bt, was Weak, 7nT or below while the north-south component was Weak and variable in direction, between -6nT and +6nT. Phi angle was negative (towards the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 remained at background below the S1 Minor Radiation Storm threshold. High energy electron flux (greater than 2MeV) observed at GOES16 were predominantly at background levels. The 24-hour fluence was steady well below the Active threshold, with 1.69e6 integrated pfu observed at 10/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High solar activity is forecast , with occasional M-class flares expected and a slight chance of isolated X-class flares.

Solar Wind /Geomagnetic Activity: There is potential for multiple CMEs to arrive today (10 Aug), but confidence remains low due to the complex halos produced by these CMEs and coinciding far side events, which complicated analysis. Additionally, a CME associated with the X1.3 flare at 08/1935UTC, which also produced a complex halo, has been analysed to have an Earth directed component and may arrive at Earth later Day 2 (11 Aug). The expected CME from the 09/2123 UTC M4.5 flare is likely to have an Earth directed component, in which case a CME may arrive through day 3 (12th). Therefore it is likely there will be some CME influence through Days 1-

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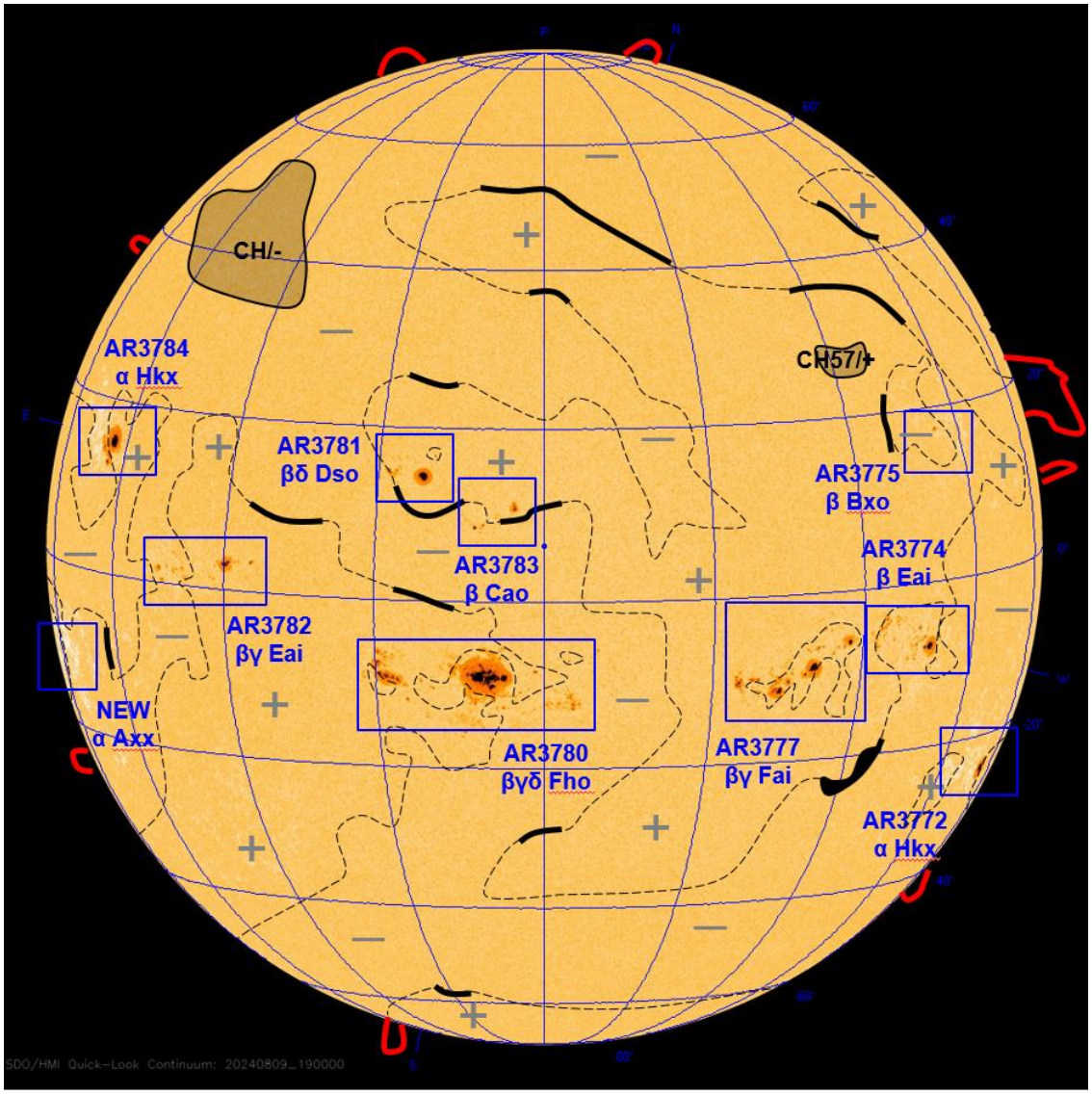
3 (10-12 Aug) though confidence in the forecast is low.

Geomagnetic activity is expected to be mostly Quiet (Kp 1-2) initially, with a slight chance of isolated Unsettled intervals. From today (10th Aug) through to day 3 (12th) occasional G1 -G2/Minor to Moderate Storms (Kp 5-6) periods are expected, with a slight chance of G3/Strong (Kp 7) storms, these most likely today and tomorrow. Geomagnetic activity is then expected to decline to mostly Quiet to Unsettled (Kp 2-3) through Day 4 (13th Aug).

Energetic Particles / Solar Radiation: High energy proton flux, as observed by GOES-18, is expected to persist at background throughout the period. Any strong flares will bring the potential for a slight chance of reaching/exceeding the S1 Minor Radiation storm level. The high energy electron flux is forecast to be at mostly background levels. The associated 24-hour fluence is expected to remain below the Active threshold (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 09/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Two CMEs occurred on the 07 Aug, one associated with the M4.5 flare from AR3774 at 07/1350UTC and a second associated with the M5.0 flare from AR3777 at 07/1854UTC. These CMEs both produced complex halos and the earlier may have coincided with a far sided event, complicating analysis. These CMEs may arrive together, with ENLIL analysis giving an arrival time this morning (10th Aug) but this is prone to uncertainty due to interference on coronograph imagery. Additionally the filament eruption CME which left the Sun on 07 Aug is expected to pass close later today (10th Aug), with glancing impacts possible. As a result, it is likely there will be some CME influence today, but confidence remains low.

A CME associated with the X1.3 flare from AR3774 at 08/1935UTC also produced a complex halo, which has been analysed to have an Earth directed component. This CME has the potential to arrive at Earth later tomorrow (11th Aug) though there is considerable uncertainty due to the challenging analysis.

A further CME is likely to join the forecast, from the M4.5 flare at 09/2123 UTC, with a possible arrival on day 3 (12th). Analysis of the CME will be undertaken once imagery is available. There is also a slight chance of a weak HSS from CH57 arriving through today, although this in appearing increasingly unlikely.

It is likely there will be some CME influence through Days 1-3 (10-12 Aug) though confidence in the forecast is low. Geomagnetic activity is expected to be mostly Quiet (Kp 1-2) initially, with a slight chance of isolated Unsettled intervals. From today (10th Aug) through to day 3 (12th) occasional G1 - G2/Minor to Moderate Storms (Kp 5-6) periods are expected, with a slight chance of G3/Strong (Kp 7) storms, these most likely today and tomorrow. Geomagnetic activity is then expected to decline to mostly Quiet to Unsettled (Kp 2-3) through Day 4 (13th Aug).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	70	70	40	10
Strong	G3	No	15	15	5	1
Severe	G4	No	1	5	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
07/1820 UTC	Partial	M4.5	SW - AR3774	660 km/s	10/0600 UTC	Low confidence due to far sided event interfering with coronagraph imagery
09/0001	Full halo	X1.3 flare	SW AR3777	750 km/s	11/1600 UTC	Complex halo causing a

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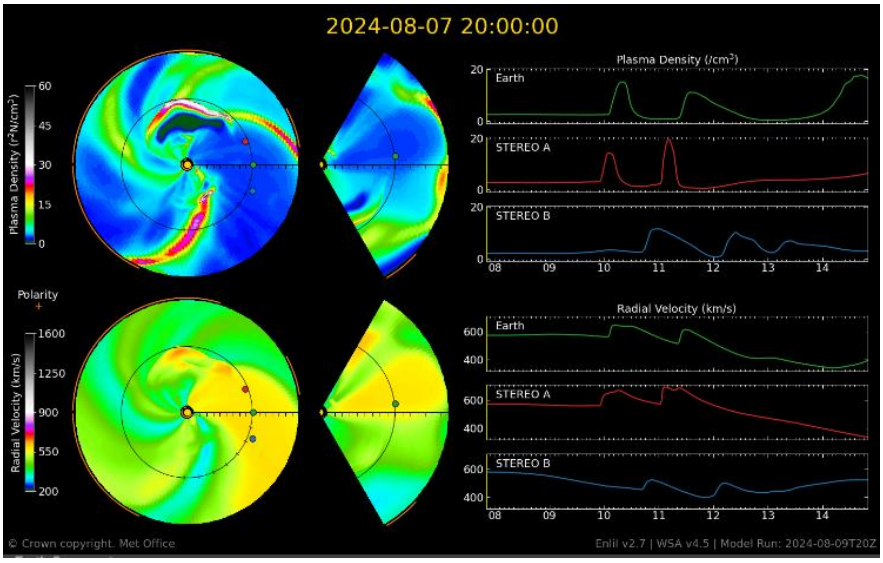
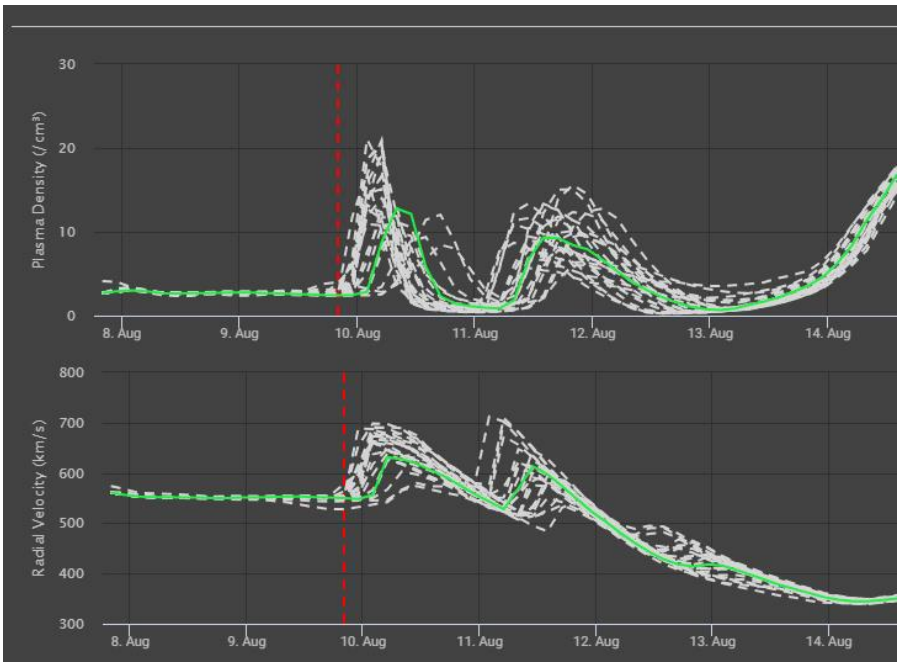
						difficult analysis, hence also low confidence.

Figure 2: MOSWOC latest Enlil (top) and ensemble forecast (below).





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Met Office Space Weather Technical Forecast

Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate with low level M-class flares observed in the past 24 hours. The largest flare was M4.5 at 09/2123 UTC from AR3777. There are currently nine numbered sunspot regions on the disc, and unusually a large number of these are magnetically complex or very complex. AR3780 (Fho/beta-gamma-delta) remains the largest region on the disc and has produced flare activity, but AR3784 (Dkc/beta-delta) is statistically the most likely to produce a significant flare. However, AR3777 (Fai/beta-gamma) has been the most active over recent days, and AR3774 and AR3781 (Dso/beta-delta) have also contributed to flare activity, despite AR3774's simpler magnetic structure (Eai/beta). AR3782 is also a region to note, due to its recent growth in spot number and magnetic complexity (now classified as Eai/beta-gamma).

Solar activity has been Moderate with four low M-class flares observed in the past 24 hours, the largest a M4.5 at 09/2123 UTC from AR3777. Further M-class flares are expected with a slight chance of an isolated X-class flare.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	No	20	20	20	20

Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES-18, was at background throughout the period. Any strong flares will bring the potential for a slight chance of reaching/exceeding the S1 Minor Radiation storm level, especially from AR3774 and AR3777 as they are currently in the western hemisphere, and also from AR3780 as it rotates into the western hemisphere later in the forecast period.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	20	20	20	20
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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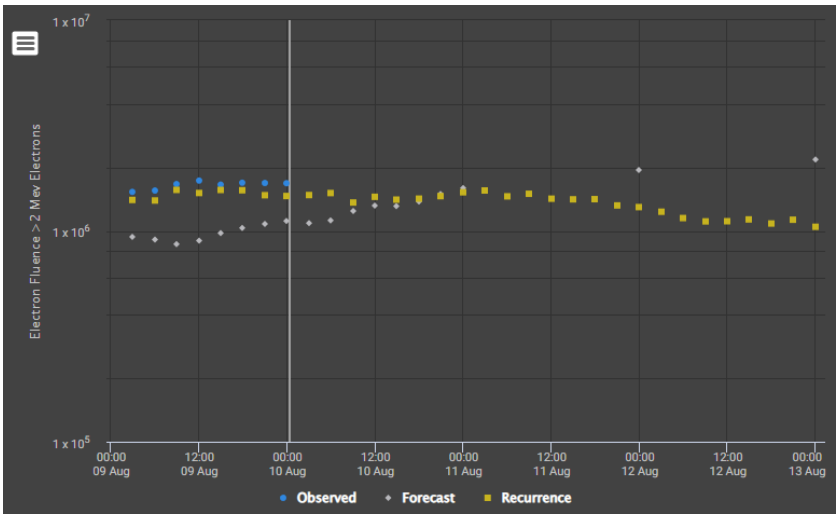
High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16, is currently at background. In the absence of any notable fast wind arrivals, the observed flux is expected to remain at or near background level.
The associated 24hr electron fluence is expected to remain below Active (1e8 integrated pfu).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: MOSWOC REFM model which is considered to be giving good guidance.



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